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Demand Elasticities for Mobile Telecommunications in Austria

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Ralf Dewenter and Justus Haucap*

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Abstract

This paper analyses price elasticities in the Austrian market for mobile telecommunications services using data on firm specific tariffs in the period between January 1998 and March 2002. Dynamic panel data regressions are used to estimate short-run and long-run demand elasticities for business customers and for private consumers with both postpaid contracts and prepaid cards. We find that business customers have a higher elasticity of demand than private consumers, where postpaid customers tend to have a higher demand elasticity than prepaid customers. Also demand is generally more elastic in the long run. In addition, the paper also provides estimates for firm-specific demand elasticities which range from –0.47 to –1.1.

JEL Classification: C23, L13, L96

Keywords: Mobile telephony, price elasticities, unbalanced panel data, dynamic panel data analysis

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1 Introduction

While mobile telecommunications markets have largely been left unregulated in Europe until recently, they have started to draw regulators' and policy makers' attention in more recent times (see, e.g., European Commission, 2007). Apart from more narrowly defined issues such as mobile number portability, mobile termination rates, and international roaming, an area of concern has also been the general competitiveness of the mobile telecommunications industry. For example, Ofcom and the UK Competition Commission have argued that the mobile telecommunications industry as a whole is not subject to effective competition, due to the oligopolistic industry configuration (see Competition Commission, 2003). Since there is only a limited amount of radio spectrum available and as the fixed and common costs associated with mobile network investments are relatively high, mobile telecommunications markets have been argued to be natural oligopolies (see Gruber, 2001; Valletti, 2003). Accordingly, concerns have been voiced by various regulatory and competition authorities about competition in mobile telecommunications markets (or, more precisely, the lack thereof), especially with respect to the potential for collusive behaviour.

In fact, as oligopolistic industries are often prone to collusion, it is important to analyse the market participants' conduct in these industries in more detail. Apart from factors such as the number of operators, barriers to entry, product differentiation, the firms' cost structures, and market transparency, one indicator for the firms' incentives to engage in collusive behaviour is the market's and the firms' demand elasticity (see, e.g., Carlton and Perloff, 2004). If the market demand is relative inelastic, the firms' rewards from engaging in collusive conduct are relatively high, as prices can be increased without loosing much custom. In contrast, a relatively elastic demand implies that the additional profit from collusion is relatively low. In addition, a high *firm-specific* elasticity of demand implies that deviating from a collusive agreement is relatively profitable (as a small price decrease generates a relatively high increase in the quantity sold) so that collusion is more likely to break down due to the "cheating problem".

Moreover, demand elasticities have also been the subject of debate in various hearings on price regulation and the allocation of common costs, for which demand elasticities play an important role (e.g., for Ramsey pricing). Hence, as demand elasticities have become a subject of debate, the number of studies that estimate demand elasticities has also been increasing, some of which are reviewed below. This paper adds to this growing literature. However, in contrast to most other research which is based on aggregate market data we had access to firm-specific data from three different competitors in the Austrian mobile telecommunications market between January 1998 and March 2002. These three firms who are the three largest mobile operators in Austria account for around 90% of the Austrian market for mobile telecommunications. In our analysis, we will use firm specific data on prices and quantities for these firms and analyse price elasticities for mobile telecommunications services. In more detail, we will first analyse demand elasticities for different market segments, namely business customers and private consumers. Moreover, we also distinguish between prepaid and postpaid contracts in the case of private households. Our results suggest that the elasticity of demand is higher for business customers than for private consumers. Moreover, postpaid consumers appear to have a more elastic demand than postpaid and prepaid consumers taken together, which suggests that prepaid customers have a lower elasticity of demand. Secondly, we analyse firm-specific demand elasticities for the three operators, yielding short-run elasticities between -0.26

and -0.40 and long-run elasticities between -0.47 and -1.1. While these findings are in line with evidence from other countries (see, e.g., New Zealand Commerce Commission, 2003), they also indicate that demand elasticities may be different for different operators. This, in turn, suggests that pricing behaviour (especially mark-ups) may be quite different between firms.

Finally, the estimation of demand elasticities also helps to determine the effects that consumer protection measures have on consumer surplus. Given the European Commission's increasing focus on consumer protection, it becomes more important to understand how different groups of consumers (e.g., business customers versus private consumers) are affected by consumer protection measures.

The remainder of the paper is now organised as follows: The next section provides an overview over empirical studies of demand elasticities in mobile telecommunications markets before section 3 offers some basic facts on the Austrian mobile telecommunications market and its historical development. In section 4 we describe the data used and present our empirical specifications for the demand equations. Finally, our main results and conclusions are summarised in section 5.

2 Brief Review of the Empirical Literature

Empirical studies on demand elasticities for mobile markets have, in principle, been using two different approaches. While the first approach is based on highly aggregated data on country or regional level, a second method to measure price elasticities relies on individual or survey data of consumer behaviour.

Independently of whether aggregated or individual data has been used most studies have found relatively moderate price elasticities. Hausman

(1999) and (2000), for example, finds a price elasticity of access to mobile services of -0.51, using aggregate data on 30 U.S. markets for the period 1988 to 1993. Analysing the price elasticity of subscription using data on 64 different countries Ahn and Lee (1999) estimate an average elasticity of -0.36.

Summarising the results from different studies by *DotEcon*, *Frontier Economics* and *Holden Pearmain*, the UK Competition Commission (2003) reports own-price elasticities of mobile subscriptions between -0.08 and -0.54. For mobile calls, own-price elasticities between -0.48 and -0.62 have been measured. In a study on the Australian mobile market *Access Economics* reports a price elasticity of -0.8 (see Competition Commission, 2003).

Rodini et al. (2002) analyse the substitutability between fixed and mobile access in the U.S. and, for this purpose, estimate own and cross-price elasticities. Using survey data on telephony services Rodini et al. (2002) find own-price elasticities of -0.43 for mobile subscription rates. Furthermore, a total elasticity of -0.6 is estimated for the access *and* usage price.

A quite different approach to analyse conduct in mobile markets has been carried out by Parker and Röller (1997) and Grzybowski (2004). Both studies apply structural models in order to examine the competitve behaviour of mobile operators. While Parker and Röller (1997) find an own-price elasticity of -2.5 using data on the United States covering the period 1984-1988, Grzybowski (2004) finds rather moderate elasticities for the EU countries in 1998-2002, ranging from -0.2 to -0.9. Similar results are reported by the New Zealand Commerce Commission (2003) and by Manfrim and da Silva (2007) for a number of additional studies.

In order to analyse the price elasticities of demand for the Austrian mobile telecommunications market, and in contrast to existing studies, we (i) use data on firm specific tariffs and (ii) apply dynamic panel techniques. By these means we are able to distinguish between short- and long–run elasticities and to distinguish between consumer behaviour at the firm level.

3 The Austrian Market for Mobile Telecommunications

In contrast to most other European countries, the Austrian market for mobile telecommunications services has only been liberalised and opened to competition relatively late, namely in 1996. While mobile telecommunications services have been offered since 1979, *Mobilkom Austria,* the former state-owned enterprise, was allowed to operate as a monopoly provider until October 1996 when *max.mobil* (now *T-Mobile Austria*) entered the market. Then two years later, *Connect Austria* (now *One*) was granted a license, and in 2000 a fourth carrier (*tele.ring*) entered the market (for details see Kruse et al., 2004). The latter operator (*tele.ring*) has been taken over by *T-Mobile Austria* in late 2006, but yet another carrier (*3 Austria*, owned by *Hutchison 3G*) has entered the market in December 2003. Furthermore, *Tele2* entered the market as a so-called mobile virtual network operator (MVNO) in 2004, using spare capacities on *One*'s network.

Even though deregulation and liberalisation have been introduced rather late, Austria is nowadays one of the few European countries with four GSM-1800 networks that provide almost full coverage.[1] Moreover, further entry may occur as another potential entrant, *3G Mobile* (*Telefonica*), was successful in the Austrian UMTS license auction in 2000 apart from the incumbents *Mobilkom Austria*, *T-Mobile*, *One* and *tele.ring* and the one entrant

[1]Other European countries with four mobile network operators are Finland, Denmark, Germany, Italy, or the UK.

(*Hutchison 3G*) that is now active in the market. Today, the Austrian mobile telecommunications industry is considered to be one of the most competitive ones in Europe (see WIK, 2002; Grzybowski, 2004).

Comparing the market shares of the "incumbent" carriers, we see that *Mobilkom*'s market share has declined significantly, while the other operators' market shares have increased (see Figure 1). In December 2005, the market share of the former state-owned monopolist, *Mobilkom*, was 39.5% (*T-Mobile* 24.4 and *One* 20.7) but, more interestingly, the share of *tele.ring* had increased from 2.6% in 2001 to 12.0% in 2005. In early 2006, *tele.ring* was integrated into *T-Mobile* and by the end of 2006 *Mobilkom*'s share had further declined to 37.6% with *T-Mobile* (incl. *tele.ring*) and *One* reaching 35.3% and 21.1%, respectively. The market share for the latest entrant, *3 Austria*, had increased to 3.3% until December 2005 and has reached 4.2% in the fourth quarter of 2006. As can also be seen from Figure 1, the shares of *T-Mobile*, the first competitor, have decreased following the market entry of *One* and *tele.ring*.

***** Insert Figure 1 about here *****

4 Empirical Analysis

4.1 Data and Empirical Specification

Data

To analyse short- and long-run elasticities, we use monthly data on mobile telephone traffic in Austria over the period from January 1998 to March 2002. The data on prices, quantities and networks' subscriber bases has been provided by the three largest Austrian mobile operators: *Mobilkom*, *One* and *T-Mobile*. In total we have information on 37 different tariffs offered by the three operators mentioned. These tariffs comprise 13 business tariffs, and 15 postpaid and 9 prepaid tariffs designed for private consumers (see Table 1 for a summary of the data). In addition, information on the price index has been gathered from official statistics of Austria.

***** Insert Table 1 about here *****

For each of these 37 tariffs the variable 'total number of outgoing minutes' measures the monthly traffic (Q). The variable consists of the sum of all outgoing call minutes, independent of the exact type of service (except for SMS or data services). Hence, the variable represents an aggregate over various services (such as on-net, off-net, mobile to fixed, and international calls) within a specific tariff. To analyse price elasticities we have calculated the average traffic per subscriber (q), using the ratio $Q/TNet$, where $TNet$ is the number of subscribers within a given tariff.

Furthermore, we had to use an average call price (P), which has been constructed by dividing the total revenue for each tariff by the total number of outgoing minutes for that tariff. While mobile markets are characterised by price differentiation between peak and off-peak times, more detailed data has not been available to us. To obtain real prices P has been deflated by the Austrian consumer price index. Furthermore, information on the firms' (total) subscriber bases ($TNet$) as well as time and firm dummies have been used as explanatory variables. All variables but the dummies are in logarithmic forms (see Table 2 in the Appendix for descriptive statistics).

Specifications

A standard approach for the estimation of demand elasticities in telecommunications is derived from the so-called Houthakker-Taylor model, which takes possible path dependencies of consumption into account (see Houthakker and Taylor, 1970). In mobile telecommunications, consumption in any given month should depend on consumption in previous months because consumers tend to conclude contracts that last for more than a month. In fact, in Austria the standard contract duration is 12 months. Even without fixed contract durations (as with prepaid contracts) switching costs matter for consumption decisions (see, e.g., Buehler, Dewenter and Haucap, 2006). Furthermore, consumer behaviour may only change gradually if consumers form habits about their calling patterns. This may also be supported by the fact that many consumers only "discover" price changes once they receive their monthly bill or once they purchase a new prepaid card. This would also suggest that some consumers do not immediately react to price changes, but only slowly. For these reasons we expect long-run elasticities to differ from short-run elasticities, as consumers may only react with some time lag. If consumers' calling behaviour is shaped by habits and routines, demand is expected to be more elastic in the long-run when consumers change their consumption patterns. According to the Houthakker-Taylor model, demand q at time t can be expressed as $q_t = q_{t-1}^{\phi} p_t^{\eta}$ where p_t denotes price at time t (see Taylor, 1994). Hence, the model allows us to distinguish between short-run and long-run elasticities of demand where short-run price elasticity is determined by η, whereas the long-run price elasticity equals $\eta/(1-\phi)$. Taking into account the panel structure of the data, the following specification can be derived:

$$\ln q_{it} = \alpha_i + \beta \ln q_{it-1} + \sum_j \gamma_j \ln p_{jt} + \sum_k \delta_k \ln x_{it,k} + \varepsilon_{it}. \tag{1}$$

where q_{it} is the average quantity demanded for tariff i at time t, p_{jt} is the respective average price for the tariff under consideration ($j = i$) and all other tariffs ($j \neq i$). Furthermore, $x_{it,k}$'s are k additional explanatory variables, ε_{it} is an error term, and β, the γ_j's and the δ_k's are the parameters to be estimated. Hence, y_i is the short-run own price elasticity and the y_j's are the short-run cross-price elasticities (for $j \neq i$). However, since usual panel data techniques lead to biased results in this case, not only because prices are endogenous, but also because of the lagged endogenous variable q_{it-1}, a dynamic panel analysis is more appropriate. Applying a first difference transformation of equation (1) leads to

$$\Delta \ln q_{it} = \beta \Delta \ln q_{it-1} + \sum_j \gamma_j \Delta \ln p_{jt} + \sum_k \delta_k \Delta \ln x_{it,k} + \Delta \varepsilon_{it}, \qquad (2)$$

which can be consistently estimated using a GMM approach as suggested by Arellano and Bond (1991).[2] Prices should, of course, be endogeneous in the data (as may be other variables such as the subscriber base). This is because consumers and mobile operators know the tariff-specific unobserved component, ε_{it}, so that the error term is correlated with the endogenous variables. In order to identify the model adequate instruments are required. An instrument is statistically valid if it is highly correlated with the variable to be instrumented and, at the same time, it is uncorrelated with the error term of the equation to be estimated. While ideally one would use a variable that identifies cost shifts, such variables are commonly not available, however. One alternative may consist in the use of lagged endogenous variables (such as p_{it-1}). This, however, may prove problematic if there is first-order

[2]Arellano and Bond (1991) also provide a heteroscedastic robust estimator. Since the GMM estimator is not consistent if variables are characterized by second order autocorrelation, Arellano and Bond have derived an adequate test of autocorrelation. Furthermore, a Sargan test of over-identifying restrictions on the number of instruments can be applied.

autocorrelation. Instead either prices for similar services or other firms's prices (or the average thereof) may be used (see, e.g. Kaiser and Wright, 2006). The intuition would be that cost shocks will affect instruments and endogenous variables in similar ways without affecting demand for the .

In the following, we will estimate both market demand elasticities for different market segments and firm-specific demand elasticities for the three mobile operators. In order to estimate market demand elasticities we will divide the Austrian mobile telecommunications market into a business and a private consumer segment. In the latter case, we will furthermore also distinguish between prepaid and postpaid tariffs.[3] For all our estimations we will use the same data described above. However, the 37 tariffs will be divided into different groups for the two estimation strategies to identify both market and firm-specific demand elasticities.

In order to address the risk of regressions being spurious we first have applied panel unit root tests for the variables used in this study. While the pooled panel estimator yields consistent estimates even if some of the variables are integrated of order one (or higher) and also independently of the existence of a cointegrating relation (see Phillips and Moon, 1999), only long-run relationships can be analysed using the integrated variables in this case. Using lagged variables is not appropriate though. Thus, the first step is to test the samples against unit roots using a non-parametric approach as suggested by Maddala and Wu (1999).[4] The authors suggest to choose a test-statistic by Fisher (1932) where the p-values of single unit root tests (π_i) from each cross-sectional unit $i = 1, \ldots, N$ are used to calculate the

[3]Note that, as in most other countries, prepaid tariffs are not used for business customers in Austria.

[4]While there is a set of unit root tests for panel data, tests such as those proposed by Im, Pesaran and Shin (1997) are not appropriate here since our samples are unbalanced.

test statistic $p_\lambda = -2\sum_{i=1}^{N}\ln(\pi_i) \sim \chi^2_{2N}$. In order to account for possible autocorrelated and heteroscdastic errors, Phillips-Perron tests (see Phillips 1987 and Phillips and Perron, 1988) have been applied to each time series to calculate respective p-values.[5] We have tested for unit roots both when tariffs are grouped into market segments (business, postpaid and prepaid customers) and when tariffs are sorted by firms (*One*, *T-Mobile* and *Mobilkom*). As one can see, Table 3 in the Appendix, which provides the unit root test statistics, there is little evidence that the variables are integrated. In all but one case ($\ln TNet$ for *Mobilkom*) the null hypothesis (existence of unit roots) can be rejected. However, one may note that looking at the individual tariff data some of the tariff time series can be found to be integrated of order one. This is not a problem for our analysis, however, as we estimate first differences as specified in equation (2).[6]

First, we have analysed demand elasticities for both business customers and private consumers, which we consider to be at least different market segments if not entirely different markets. Since estimating all cross-price elasticities, as indicated in equation (2), has lead to manifest problems of multicollinearity, we had to confine ourselves to the estimations of own-price elasticities only. We consider this less dramatic than it may appear at first sight because most consumers will only respond to price changes within their chosen tariff, as they cannot easily switch to possibly less expensive tariffs, at least not in the short-run, due to contract duration and other switching costs. Of course, our estimated long-run elasticities may be underestimated

[5]The number of lags used for each series has been calculated by $l = int(4 \cdot (T/100)^{(2/9)})$ (see Newey and West, 1987), where T is the number of observations.

[6]The problem of unit roots is typically not addressed when telecommunications demand is estimated. For example, both Das and Srinivasan (1999) and Ahn and Lee (1999) neglect the problem of non-stationary variables so that spurious correlations may lead to biased results.

as cross-price effects have been neglected. This means that the true long-run elasticities should be higher than our estimates.

As prices are clearly endogenous, as may be the size of the subscriber base, we have to instrument both explanatory variables in our equations to be estimated.[7] For our estimations of the demand elasticity of business customers, we use the average price and subscriber base of prepaid contracts as instruments. Conversely, to estimate the demand elasticities for the two private consumer market segments (prepaid and postpaid) we use the average price and subscriber base of business customers as instruments. The reason is that we expect the different market segments' demand functions to be largely independent from each other, while, at the same time, we expect cost shocks to affect both market segments in similar ways. Hence, we consider these instruments to be valid.[8] To estimate firm-specific demand elasticities, we have also used the average prices and subscriber bases of prepaid contracts as instruments for the respective variables of business customers and average business prices and subscriber bases to instrument private consumer variables. As can be seen from Tables 4 and 5 Sargan tests cannot reject orthogonality of the instruments at the usual signifcance levels.

4.2 Results

Table 4 presents the results of our analysis for different market segments. Almost all relevant coefficients are statistically significant and show the expected signs. The coefficients $\Delta \ln p_t$ can be interpreted as short-run demand

[7]Hausman-Wu tests (see Greene, 2003) have been applied to test for the possible endogeneity of current prices and the size of the subscriber base. However, the tests failed to reject the null hypothesis of exogeneity.

[8]In another set of regressions, we have also used lagged prices and lagged subscriber base figures as alternative instruments. The results to be presented below remained largely unchanged.

elasticities. If business customers and private consumers are considered to be entirely different markets (and not only market segments), the estimated coefficients can be interpreted as market demand elasticities. In line with almost all other empirical studies of telecommunications demand, the demand for mobile telecommunications services in Austria is found to be relatively inelastic in the short run. However, business customers have a more elastic demand (-0.33) than private consumers (-0.14).[9] Among the private consumers demand appears to be more elastic for customers on postpaid contracts (-0.22) than for prepaid contract customers where we do not find a statitically significant elasticity. While it may appear somewhat surprising that business consumers have a more elastic demand (given that a firm's employees ususally do not pay for calls themselves so that a principal-agent problem results), the lower demand elasticity for private consumers may be due to the low demand elasticity that prepaid consumers exhibit. In fact, the long-run elasticities of demand are roughly the same for business customers and private postpaid consumers. Moreover, principal-agent problems should be less severe in small and family firms which may exhibit a larger elasticity of demand.

Regarding prepaid tariffs, we were unable to find a significant demand elasticity. A potential reason may be that many (if not most) consumers appear to purchase a prepaid card (usually bundled with a mobile telephone) in order to *receive* calls and not to place calls. Furthermore, subscriber numbers are less reliable than for either business or postpaid customers because consumers do not have to cancel their contract once they decide not to use their prepaid account any longer. Hence, the subscriber number for prepaid consumers may be overstated in our sample (and the operators' accounts,

[9]The 24 private consumer tariffs consist of the sum of the 15 postpaid and the 9 prepaid tariffs.

respectively), and, therefore, the traffic per *active* subscriber understated. As expected, long-run elasticities are higher for all market segments in line with the reasoning provided above.

Also note that the past month's traffic positively affects current traffic numbers. As mentioned before, this is not surprising given habitual consumer behaviour. Since q_t is defined as $q_t \equiv Q_t/TNet$, a negative coefficient for $\ln TNet$ means that the average quantity consumed per subscriber is decreasing with an increasing subscriber base. One reason should be that the marginal customer consumes less than the average customer. This means, that additional consumers (who are relatively late adapters) use their mobile telephone less than the early adapters. The finding may also suggest that firm-specific network effects (should they exist, maybe due to a differentiation between on-net and off-net tariffs), are not so strong that additional customers would lead to an increase in the average quantity consumed.[10]

***** Insert Table 4 about here *****

Analysing firms instead of market segments leads to quite different results, as elasticities can now be interpreted as firm-specific rather than market demand elasticities. As can be seen from Table 5, short-run as well as long-run elasticities tend to be a bit higher on average than those calculated for market segments. The reasoning behind these differences is that firms compete with each other over similar tariffs (i.e. prepaid, postpaid and business tariffs). Price changes should therefore lead to stronger variations in short-run demand and also result in higher churn rates which in turn increases

[10]Note that with strong network effects adding another consumer could lead to an increase in the average quantity consumed. To explore this possibility, we have not only used $TNet$, but also the variable Net (which is the subscriber base per tariff). However, neither use of the tariff specific subscriber base (Net) nor use of the firm's total subscriber base ($TNet$) has produced evidence for such strong network effects.

long-run demand elasticities. Again, long-run elasticities are, as expected, considerably higher than short-run numbers. For example the average price elasticity of demand is about -1.1 for *T-Mobile*, which is relatively high compared to other studies. Moreover, subscriber bases have, again, a negative and statictically significant impact on demand per subscriber.

***** Insert Table 5 about here *****

5 Summary and Conclusions

In this paper we have analysed the demand for mobile telecommunications services in Austria. Dynamic panel data techniques have been applied in order to estimate short- and long-run price elasticities. In contrast to most other research we had access to firm-specific data on 37 different tariffs from three competitors in three market segments (business customers, postpaid and prepaid private consumers) between January 1998 and March 2002. These three firms who are the three largest mobile operators in Austria have accounted for around 90% of the Austrian mobile telecommunications market for the period of our analysis.

First, we have analysed short-run demand elasticities for business customers and private consumers and have, in a second step, also distinguished between prepaid and postpaid contracts in the case of private households. Our results suggest that business customers have a more elastic demand than private consumers. Among the private consumers demand appears to be more elastic for customers on postpaid contracts than for prepaid contract customers where we do not find a statistically significant elasticity. Long-run elasticities are higher for all market segments which is consistent with our expectations as habitual behaviour with respect to consumer calling habits will only change slowly. Furthermore, consumers cannot easily switch to possibly less expensive tariffs in the short-run due to contract duration and other switching costs. And finally consumers may also only react slowly to price changes as they only "discover" the new prices once they receive their monthly bill in the case of postpaid customers and possibly even later in the case of prepaid customers.

Moreover, we have analysed firm-specific demand elasticities for the three operators, yielding short-run elasticities between -0.26 and -0.40 and long-run elasticities between -0.46 and -1.1. The differences between the operators' demand elasticities suggests that mark-ups between firms will also differ, which should be taken into account for competition analysis purposes.

Finally, we have found subscriber bases to have a negative and statictically significant impact on demand per subscriber in all of our regressions, which may suggest that additional consumers (who are relatively late adapters) use their mobile telephone less than the early adapters. In contrast, the past month's traffic positively affects current traffic numbers in our regressions which supports the notion that habitual consumer behavioûr may also play a role in mobile telecommunications as suggested by Taylor (1994).

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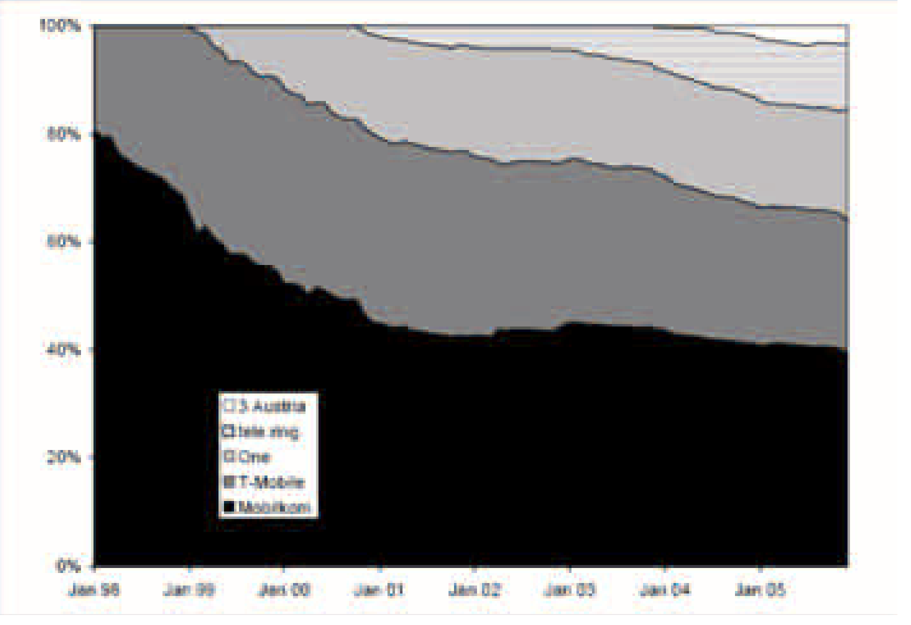

Figure 1:

Mobile Operators' Market Shares (1998-2005; Source: RTR, 2006)

Table 1: Data

Tariff	Operator	Nobs
Business tariffs		
A1 Company	Mobilkom	39
A1 Corporate	Mobilkom	39
TACS Business	Mobilkom	39
TACS Compact	Mobilkom	39
ONE Company	One	32
ONE Company Special	One	32
ONE Family	One	32
ONE Group DUAL VPN	One	32
ONE Group VPN Special	One	32
ONE Standard Special	One	32
One Group VPN	One	32
Standard	One	32
company.max	T-Mobile	39
Postpaid tariffs		
A1 Fun	Mobilkom	39
A1 Matik	Mobilkom	39
A1 Start	Mobilkom	39
A1 Xcite	Mobilkom	39
TACS Privat	Mobilkom	39
Classic	One	32
ONE 99	One	32
ONE 99 New	One	32
ONE Classic New	One	32
ONE Classic Special	One	32
freizeit.max	T-Mobile	39
freizeit.max.oE	T-Mobile	39
mini.max	T-Mobile	39
mini.max.oE	T-Mobile	39
profi.max	T-Mobile	39
Prepaid tariffs		
B-free Classic	Mobilkom	39
B-free Kids	Mobilkom	39
B-free Quickstart	Mobilkom	39
B-free Weekend	Mobilkom	39
Take ONE	One	32
Take ONE 3Zeit Abend	One	32
Take ONE 3Zeit Mittag	One	32
Take ONE 3Zeit Morgen	One	32
klax.max	T-Mobile	39

Table 2: Descriptive Statistics

	$\ln p_t$	$\ln q_t$	$\ln TNet$
Business tariffs			
Mean	-5.25	5.39	8.81
N	348	327	327
S.D.	0.76	0.73	2.85
Postpaid tariffs			
Mean	-5.25	4.93	10.51
N	369	346	380
S.D.	0.89	0.67	2.31
Prepaid tariffs			
Mean	-4.82	3.60	10.51
N	243	216	221
S.D.	0.67	0.65	3.32
One			
Mean	-5.84	4.95	8.05
N	273	345	374
S.D.	0.36	0.76	3.03
T-Mobile			
Mean	-5.81	4.72	11.68
N	208	196	206
S.D.	0.63 0.97	1.44	
Mobilkom			
Mean	-4.45	4.65	10.86
N	479	348	348
S.D.	0.36	1.14	2.15

Table 3: Maddala-Wu Unit Root Tests

	lnp_t	lnq_t	ln$TNet$
Business tariffs			
χ^2	88.53	187.73	114.83
(Prob.)	(0.00)	(0.00)	(0.00)
Postpaid tariffs			
χ^2	98.43	243.98	198.57
(Prob.)	(0.00)	(0.00)	(0.00)
Prepaid tariffs			
χ^2	171.44	121.10	56.82
(Prob.)	(0.00)	(0.00)	(0.00)
One			
χ^2	134.82	273.91	228.88
(Prob.)	(0.00)	(0.00)	(0.00)
T-Mobile			
χ^2	30.85	115.87	112.48
(Prob.)	(0.00)	(0.00)	(0.00)
Mobilkom			
χ^2	72.29	122.36	28.87
(Prob.)	(0.00)	(0.00)	(0.31)

Table 4: One-Step GMM Estimates of Mobile Demand (Customer Groups)

	Business Tariffs	*Private Consumer Tariffs*	*Postpaid Tariffs*	*Prepaid Tariffs*
$\Delta\ln q_{t-1}$	0.5509	0.6249	0.6374	0.5790
	(10.70)	(10.90)	(5.24)	(7.37)
$\Delta\ln p_t$	-0.3316	-0.1393	-0.2437	-0.0828
	(-4.52)	(-1.93)	(-3.36)	(-1.54)
$\Delta\ln TNet$	-0.0324	-0.0788	-0.0187	-0.1693
	(-2.84)	(-2.50)	(-0.97)	(-12.66)
Constant	-0.0008	-0.0008	-0.0030	0.0040
	(-0.32)	(-0.32)	(-1.08)	(0.58)
Time Dummies	YES	YES	YES	YES
Sargan Test	285.25	528.25	371.04	199.64
(Prob.)	(0.22)	(0.27)	(0.54)	(0.33)
AR(1)-Test	-6.63	-7.66	-1.49	-4.82
(Prob.)	(0.00)	(0.00)	(0.13)	(0.00)
AR(2)-Test	-1.04	-1.22	1.21	-1.31
(Prob.)	(0.29)	(0.22)	(0.22)	(0.19)
Nobs	272	476	286	190
No. of Groups	13	24	15	9
Long Run Elasticity	-0.74	-0.37	-0.67	-0.20
Standard Error	0.0857	0.0275	0.1429	0.2419

Note: Heteroskedasticity consistent z-statistics are given in parenthesis. Standard errors for long-run elasticities calculated using the delta method (see Greene,2003).

Table 5: One-Step GMM Estimates of Mobile Demand (Firms)

	One	*T-Mobile*	*Mobilkom*
$\Delta \ln q_{t-1}$	0.4423	0.6380	0.6879
	(5.70)	(5.93)	(11.02)
$\Delta \ln p_t$	-0.2594	-0.3976	-0.3354
	(-4.47)	(-4.45)	(-2.43)
$\Delta \ln TNet$	-0.0606	-0.1358	-0.1230
	(-2.27)	(-3.85)	(-1.23)
Constant	-0.0006	0.0018	-0.0059
	(0.17)	(1.62)	(-1.70)
Time Dummies	YES	YES	YES
Sargan Test	369.00	204.57	309.20
(Prob.)	(0.33)	(0.22)	(0.31)
AR(1)-Test	-4.31	-4.92	-7.08
(Prob.)	(0.00)	(0.00)	(0.00)
AR(2)-Test	-1.02	0.89	-1.13
(Prob.)	(0.30)	(0.37)	(0.26)
Nobs	254	176	322
No. of Groups	17	7	13
Long Run Elasticity	-0.47	-1.10	-1.08
Standard Error	0.0524	0.1153	0.2529

Note: Heteroskedasticity consistent z-statistics are given in parenthesis.

Standard errors for long-run elasticities calculated using the delta method (see Greene,2003).